

WHAT IS CLAIMED IS:

1. A sheet bending apparatus comprising:

5 a first shaping mold having a major surface, a portion of the major surface comprising a shaping member having a predetermined shaped press face;

10 an outline shaping mold defined as a second mold, the second mold having a pair of spaced end rails and a pair of spaced central rails between the spaced end rails, the pair of spaced end rails and the pair of spaced central rails defining a boundary around an open area and portions of the end rails and the central rails providing a sheet supporting surface;

15 an outer wall between the first and second molds, the outer wall defining a boundary with the sheet supporting surface within the boundary defined by the outer wall;

20 an elevator arrangement acting on at least one of the first and second molds to move the first and second molds relative to one another between a first position, wherein the first and second molds are spaced from one another and the outer wall is spaced from at least one of the first and second molds, and a second position, wherein the first and second molds, and the outer wall form an enclosure having the sheet supporting surface of the second mold and the shaping member of the first mold facing the enclosure, and ambient air is accessible to the enclosure at least through the open area, and

25 at least one passageway other than the open area having a first end in fluid contact with the enclosure and the second opposite end outside the enclosure.

2. The bending apparatus according to claim 1, wherein the end rails and the central rails of the second mold are continuous and form a continuous sheet supporting surface.
- 5 3. The bending apparatus according to claim 1, wherein the central rails are secured in position and the end rails are pivotally mounted to pivot from a first position where the end rails and the central rails provide for a generally horizontal support for a sheet to a second position where portions of the ends of the end rails are raised above the central rails.
- 10 4. The bending apparatus according to claim 1, wherein the outer wall is mounted to the second major surface of the first mold.
5. The bending apparatus according to claim 4, wherein the outer wall
15 surrounds and is spaced from the shaping member of the first mold.
6. The bending apparatus according to claim 1, wherein the outer wall is mounted to the central rails and the end rails.
- 20 7. The bending apparatus according to claim 1, wherein the outer wall has one part of an aligning arrangement and the first mold and/or the second mold has another part of the aligning arrangement.
8. The bending apparatus according to claim 7, wherein the central rails
25 and the end rails have a "T" shaped cross section defined as a "T" rail with the horizontal member of the "T" rail having the sheet supporting surface.
9. The bending apparatus according to claim 8, wherein the outer wall is
30 extends away from the "T" rail.

10. The bending apparatus according to claim 8, wherein the outer wall is connected to the horizontal member of the "T" rail and extends away from the "T" rail and the open area.

5 11. The bending apparatus according to claim 8, wherein the sheet supporting surface is a portion of the horizontal member of the "T" rail adjacent the open area and the outer wall is portion of the horizontal member of the "T" farthest from the open area.

10 12. The bending apparatus according to claim 6, wherein the central rails and the end rails have an "I" shaped cross section defined as an "I" rail and the upper end of the "I" rail is the sheet supporting surface and the outer wall has one end mounted to outer vertical surface of the "I" rail and extends away from the "I" rail and the open area.

15

13. The bending apparatus according to claim 1, wherein the first shaping mold further comprises a plate member having a first major surface and a second opposite major surface wherein the major surface of the first mold having the shaping member is the second surface of the plate member and
20 the shaping member extends away from the second surface of the plate member, a plenum over a portion of the first surface of the plate member, the at least one passageway is one of a plurality of spaced passageways with selected ones of the plurality of the passageways having the first end in fluid contact with the interior of the enclosure at positions spaced from the shaping
25 member and the second end in fluid contact with interior of the plenum.

14. The bending apparatus according to claim 1, wherein the first shaping mold further comprises a plate member having a first major surface and a second opposite major surface wherein the major surface of the first mold
30 having the shaping member is the second surface of the plate member and the shaping member extends away from the second surface of the plate

member, a plenum over a portion of the first surface of the plate member, the at least one passageway is one of a plurality of spaced passageways with selected ones of the plurality of the passageways having the first end in fluid contact with the interior of the enclosure at positions along the marginal edge portions of the shaping member and the second end in fluid contact with interior of the plenum.

15. The bending apparatus according to claim 1, wherein the at least one passageway is one of a plurality of passageways with selected ones of the passageways having the first end adjacent at least one peripheral edge of the shaping member of the first mold when the first and second molds and the outer wall are in the second position with the selected ones of the passageways passing through the outer wall and the second end of the selected ones of the passageways at or extending beyond the outer surface of the outer wall.

16. The bending apparatus according to claim 1, wherein the at least one passageway is one of a plurality of passageways with selected ones of the passageways having the first end adjacent peripheral edges of the shaping member when the first and second molds and the outer wall are in the second position with the selected ones of the plurality of passageways passing through the second mold and the second end of the selected ones of the plurality of passageways accessible from the exterior of the second mold.

17. The bending apparatus according to claim 1, wherein the shaping member has a press face and the at least one passageway is one of a first plurality of passageways and further including a second plurality of passageways, the second plurality of passageways having a first end at the press face of the shaping member, the second plurality of passageways passing through the shaping member.

18. The bending apparatus according to claim 17, wherein the second plurality of passageways have a second opposite end and further comprising a first plenum over the second end of the first plurality of passageways and a second plenum over the second end of the second plurality of passageways.

5

19. The bending apparatus according to claim 18, wherein the second plenum is inside the first plenum and the first plenum is connected by a conduit to a vacuum pump and the second plenum is connected by a conduit to a valve having a first open position and a second open position with the
10 valve in the first open position connected by a conduit to the vacuum pump and with the valve in the second position connected by a conduit to a pressurized fluid system.

20. The bending apparatus according to claim 17, further comprising a
15 mesh cloth securely mounted over the press face of the shaping member, the mesh cloth having a predetermined weave to provide spacing of a predetermined distance, wherein the opening of the first end of the second plurality of passageways is equal to or less than the spacing of the weave of the mesh cloth overlying the second end of the second plurality of
20 passageways.

21. The bending apparatus according to claim 17, wherein the second plurality of passageways has a second end opposite the first end and at least one of the passageways of the second plurality of passageways has a first
25 end opening greater than second end opening at the press face and further comprising a plate having a plurality of spaced holes therethrough mounted in the second end opening of the at least one of the second plurality of passageways.

30 22. The bending apparatus according to claim 21, further comprising a mesh cloth securely mounted over the press face of the shaping member, the

mesh of the cloth having a predetermined weave to provide spacing of a predetermined opening, wherein the size of the opening of the holes in the plate are equal to or less than the size of the openings in the mesh cloth overlying the holes in the plate.

5

23. The bending apparatus according to claim 1, wherein the shaping member comprises a press face and further comprising a mesh cloth securely mounted over the press face of the shaping member of the first mold and at least the sheet supporting surface of the second mold.

10

24. The bending apparatus according to claim 1, wherein the first mold is mounted in a pressing station, the pressing station having an upstream end and a downstream end and further comprising a heating furnace connected to the upstream end of pressing station, a cooling furnace connected to the downstream end of the pressing station and a conveying system extending through the heating furnace, the pressing station and the cooling furnace to move the second mold along a path through the heating furnace, the pressing station and the cooling furnace.

15

20 25. The bending apparatus according to claim 23, wherein the pressing station further comprises an upper elongated rod to move the first mold toward and away from a portion of the conveying system in the pressing station and a lower elongated rod moveable toward and away from the first mold.

25

26. The bending apparatus according to claim 25, further comprising a carriage moveable by the conveying system along the path, wherein the second mold is mounted on the carriage to move the second mold through the heating furnace, the pressing station and the cooling furnace, wherein the carriage moved into the pressing station is in the first position and the lower

30

elongated rod moves the second mold toward the first mold to position the second mold, the first mold and the outer wall in the second position.

27. The bending apparatus according to claim 1, wherein the first mold and
5 the second mold are mounted in a pressing station, the pressing station
having an upstream end and a downstream end, and further comprising a
heating furnace connected to the upstream end of pressing station, a cooling
furnace connected to the downstream end of the furnace, a sheet conveying
system extending through the heating furnace and the cooling furnace and an
10 upstream sheet transfer device mounted for movement from a position over a
portion of the conveying system in the heating furnace to a position over the
second mold.

28. The bending apparatus according to claim 27, further comprising a
15 downstream transfer device mounted for movement between a position over
the second mold to a position over a portion of the conveying system in
cooling furnace.

29. A sheet bending apparatus comprising:
20 a chamber having outer walls, an entrance end, an exit end, an
entrance door and an exit door;
a first shaping mold mounted in the chamber, the first shaping mold
having a major surface having a shaping member having a
predetermined shaped press face;
25 an outline shaping mold defined as a second mold mounted in the
chamber in facing relationship to the first mold, the second mold having a
pair of spaced end rails and a pair of spaced central rails between the
spaced end rails, wherein portions of the end rails and the central rails
provide a sheet supporting surface with an open area within the
30 boundary of the sheet supporting surface;

an elevator arrangement acting on at least one of the first and second molds to move the first and second molds relative to one another between a sheet receiving position where the first and second molds are spaced from one another, and a sheet pressing position where the first and second molds are closer to one another than when in the first position;

a vacuum pump connected to the interior of the pressing chamber, and

a conduit having one end connected to the open area between the shaping rails and the opposite end connected to an air supply.

30. A shaping mold comprising:

a shaping member having a shaped pressing face and an opposite major surface;

at least one passageway extending through the shaping member, the passageway having one end terminating at the pressing face and the opposite end terminating at the major surface, the end terminating at the pressing face having a predetermined open area, and

a cloth covering the pressing face with a portion of the cloth overlaying the end of the passageway terminating at the pressing face of the shaping member, wherein open area of weave of the cloth at the portion overlaying the end of the passageway has a predetermined open area equal to or greater than the predetermined open area of the passageway.

31. A method of bending a sheet comprising the steps of:

engaging marginal edge portions of a major surface defined as the first major surface of a stack of one or more sheets;

moving opposite major surface of the stack of sheets defined as the second major surface against the press face of a shaping member;

applying a vacuum to peripheral edges of the stack to at least pull air from between the press face and the second major surface, while

5 applying pressure to the first major surface to bias the stack against the press face of the shaping member to bend the stack of sheets to a predetermined shape.

32. The method according to claim 31, wherein the sheets are glass sheets and the stack is a stack of two glass sheets, further comprising the steps of:

10 prior to the practice of the engaging step, heating the stack of sheets to their deformation temperature, and

 after the sheets are bent to a predetermined shape, discontinue the practice of the applying a vacuum step and applying pressure step, and practice the steps of :

15 displacing the shaped sheets away from the press face, and
 controllably cooling the shaped glass sheets.

33. The method according to claim 32, further comprising the step of
20 pulling a vacuum through the press face to bias central portion of the second major surface against the press face and wherein the displacing step comprises the step of moving pressurized air against the central portion of the second major surface to move the sheets away from the press face of the shaping member.

25

34. The method according to claim 32, further comprising the steps of laminating the shaped glass sheets to provide a laminated automotive window.

35. The method according to claim 33, further comprising the step of pulling a vacuum through the press face to bias central portion of the second major surface against the press face.

5 36. The method according to claim 35, wherein after the sheets are bent to a predetermined shape, discontinue the practice of the applying a vacuum step, the pulling a vacuum step and the applying pressure step, and practice the steps of:

10 moving pressurized heated air against the central portion of the first major surface of the shaped sheets to move the shaped sheets away from the press face, and
controllably cooling the shaped glass sheets.

37. The automotive window made according to the method of claim 34.